ISSN 1346-7565 Acta Phytotax. Geobot. 60 (2): 71–78 (2009)

A New Species of *Pandanus* (Pandanaceae) from the Daito Islands of Japan

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A new species, *Pandanus daitoensis* Susanti & J. Miyam. (Pandanaceae) is described from Kita-Daito Island near the Ryukyu Archipelago, Japan, in the North Pacific Ocean. *Pandanus daitoensis* is closest to *P. duriocarpus* Martelli (subg. *Pandanus*), but can be distinguished by its two rows of flexed acute carpels resulting in a surface of curved phalanges. Each carpel has dark brown longitudinal grooves extending from the stigma to the carpel base.

Keywords: Borodino Islands, Kita-Daito Island, new taxa, Pandanaceae, *Pandanus daitoensis*

The Pandanaceae consist of four genera: *Pandanus, Freycinetia, Sararanga* and *Martellidendron*. *Martellidendron* was recently separated from *Pandanus* and recognized as a new genus by Callmander *et al.* (2003). Among the four genera, *Pandanus* has the widest distribution in the tropics and subtropics (Stone 1975a) and comprises about 600 species (St. John 1960a, Stone 1975a, 1983a, Callmander *et al.* 2003). Three species are in Japan (Makino 1986, Yamazaki 1986, Satake *et al.* 1989). *Pandanus odoratissimus* L.f., is commonly found along beaches from the Indian Ocean and Malesia to as far north as southern Japan (Stone 1967a), where it occurs from Yonaguni-jima north to Kuchino-shima in the Ryukyu Islands and on the Daito Islands (Hatusima 1986). Sugimoto (1961) recognized two varieties of *Pandanus tectorius* Sol., var. *liukiuensis* Warb. and var. *laevis* Warb., in Japan. *Pandanus boninensis* Warb. is endemic to the Bonin Islands (Satake *et al.* 1989, Toyoda 2003), and *P. cetrifugalis* H. St.John (= *P. furusei* Hatus.) was introduced to Chichi-jima in the Bonin Islands (Hatusima 1977, Yamazaki 1986).

In 2008, we visited the central basin of Kita-Daito Island in Shimajiri-gun, Okinawa Prefecture, Japan, to observe and to collect specimens of an unknown *Pandanus*. The plants were discovered in 2007 by Ms. Rieko Oshiro and Mr. Morio Shiroma of Kitadaito Village, who informed us of their finding. We analyzed the morphological characteristics of the vegetative organs in the field. In Pandanaceae, the multiple fruit is called a cephalium and consists of phalanges, each containing one or more drupes. Mature leaves and cephalia were collected and dried for herbarium specimens. The phalanges were dried or preserved in FAA (formalin acetic alcohol) solution and cut to observe the endocarp and ovule. We were unable to identify the plants to any known species of Asian or Oceanian *Pandanus* using published descriptions or specimen in Herbarium Bogoriense (BO), Kyushu University Museum (FU) and Kagoshima University Museum (KAG) and decided that they represent and undescribed species. We here describe these plants as *P. daitoensis* Susanti & J. Miyam.

Monographs and infrageneric systematics of *Pandanus* are few and do not cover all species (Rumphius 1743, Stone 1974, Warburg 1900). Among the eight subgenera of *Pandanus*, *Rykia* (de Vriese) B.C. Stone, *Lophostigma* (Brongn.) H.

St.John, emend. B.C. Stone, *Kurzia* B.C. Stone, *Vinsonia* B.C. Stone, *Pandanus* sensu B.C. Stone non H. St.John, *Coronata* Martelli, *Acrostigma* (Kurz) B.C. Stone and *Martellidendron* (Pic. Serm.) B.C. Stone, recognized by Stone (1974), *Pandanus daitoensis* belongs to subgenus *Pandanus* based on the multicarpellate phalanges (polydrupes) with connate carpels.

Subgenus *Pandanus* includes nine sections, *Pandanus* (Syn. *Keura* (Forssk.) Warb.), *Fagerlindia* B.C. Stone, *Elmeria* B.C. Stone, *Athrostigma* B.C. Stone, *Intraobtutus* H. St.John, *Australibrassia* H. St.John, *Semikeura* B.C. Stone, *Excavata* B.C. Stone and *Megakeura* B.C. Stone. We regard *P. daitoensis* to belong to sections *Pandanus, Excavata* or *Megakeura* because of the unarmed ventral pleats. Since *P. daitoensis* does not have concave phalanges with a truncate to concave apex, its placement in section *Excavata* was excluded. The main character used to recognize section *Megakeura* is the pistillode in the staminate phalanges. Unfortunately, we could not determine this character in *P. daitoensis*, since staminate individuals were not found.

We conducted a literature review of the species in sects. *Pandanus* and *Megakeura*, and of other species not mentioned in Stone (1974), from several areas: Africa, Madagascar and beaches along the Indian Ocean (Callmander *et al.* 2003, St. John 1961a, 1974, Stone 1970, 1973, 1975b), Malesia and Southeast Asia (Kanehira 1938a, St. John 1961b, 1962a, 1965a, 1965b, Stone 1965, 1966, 1968a, 1968b, 1972, 1983b, 1993), northern Asia, including China and Japan (St. John 1962b, Hatusima 1971, 1986, 2004, Makino 1986, Satake *et al.* 1989, Toyoda 2003), New Guinea (Merrill & Perry 1939, Kanehira 1940, 1941, Stone 1984, 1992), Australia (St. John 1961a, 1961c, 1962c, 1962d, Stone 1995) and the Pacific region (Kanehira 1933, 1934, 1935a, 1935b, 1936a, 1936b, 1936c, 1937a, 1937b, 1938b, St. John 1956, 1960b, Stone 1961, 1967b, 1975c) and concluded that *P. daitoensis* is closely related to *P. duriocarpus* Martelli (Subgen. *Pandanus*) from Micronesia (Kanehira 1934). The systematic position of *P. duriocarpus* was not mentioned be either Stone (1974) or Warburg (1900), even in synonymy. *Pandanus duriocarpus* was placed in subgenus *Keura* by Kanehira (1934), which was considered to be a synonym of subgenus *Pandanus* by Stone (1974). A comparison of *P. daitoensis* and the type specimen of *P. duriocarpus* stored in the Kyushu University Museum (FU) is presented in Table 1.

TABLE 1. Comparison of morphological characters between *Pandanus daitoensis* and *P. duriocarpus*. Observation of P. duriocarpus was made based on two specimens, *Kanehira 822* (Holotype, FU) from Palau and *Kanehira 3760* (FU) from Tokobe, Palau Islands. Leaf of the type specimen measured has incomplete proximal part, thus leaf length might be more than 82 cm (*).

Species	***P. daitoensis***	*P. duriocarpus*
syncarp shape	**subglobose to trigonal shape**	ovatus to subglobose with trigonal shape
syncarp diameter (D cm)	**11–13**	16–18
syncarp length (L cm)	**15–17**	13
number of phalanges	**90–95**	90
phalange width (W cm)	**2.5–4**	3–4.5
phalange length (L cm)	**4.5–5.5**	4–7
phalange surface	**convex**	flat
number of carpel per phalange	**(8–) 11 (–16)**	16–18
apical sinuses (cm)	**2.5–3**	0.5–1
apical carpel shape	**convex to acute, flexed outward**	acute
longitudinal grooves	**present**	absent
leaves length (cm)	**110–144 cm**	82*
leaves width (cm)	**5–5.5**	5

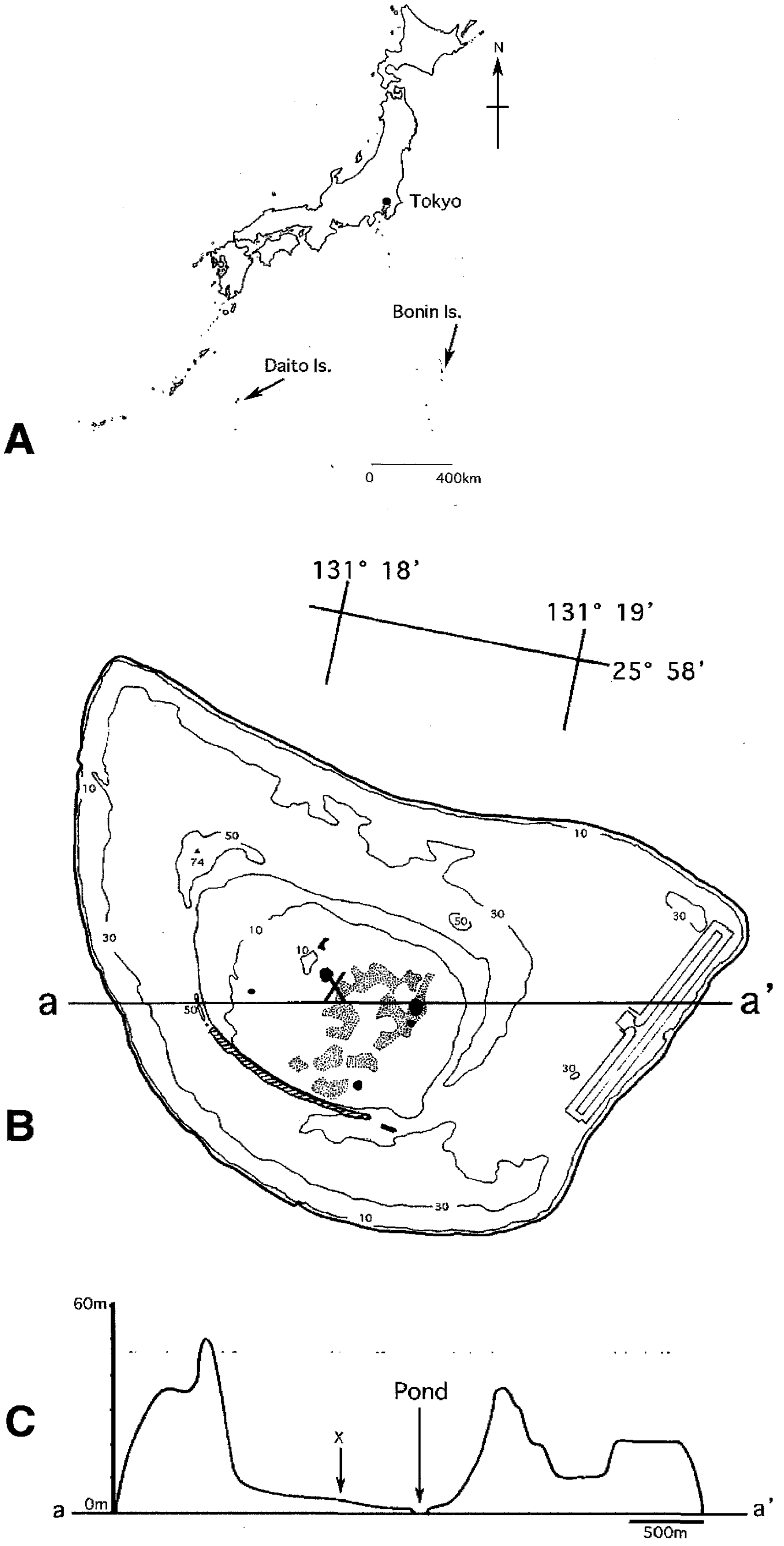

FIG. 1. Location of *Pandanus daitoensis*. A: location of Daito Islands in Japan. B: Kita-Daito Island. Symbol '×' indicates sampling points for *P. daitoensis*. Solid black areas, white areas with black dots and striped area indicate ponds, swamps and cliffs, respectively. C: topographic cross section along line a–a' in B. Symbol '×' indicates sampling points.

Pandanus daitoensis and *P. duriocarpus* have syncarps and leaves of similar shape and size. Externally, the syncarp appears to be composed of single acute drupe. Morphologically, however, it is composed by polydrupes, or phalanges. The border between the phalanges is not obvious. The leaves of the two species always have an unarmed ventral pleat with prickles along the margins and midrib. The carpels of both species are acute and deep sinuses separate the apical portions. From the side, the lateral suture between the carpels is easily observed. We could not find these characters in common in other species of section *Pandanus*.

The distinguishing feature of *Pandanus daitoensis* are in the phalanges, which are composed of two rows of flexed acute carpels resulting in a curved phalange surface, while the surface of the phalanges in *P. duriocarpus* is nearly flat. The individual carpel of *P. daitoensis* is dark brown with longitudinal grooves extending from the stigma to the base of the carpel, which is not found in *P. duriocarpus*.

Taxonomy

Pandanus daitoensis Susanti & J. Miyam., **sp. nov.** (Figs. 2 & 3)

Syncarpium solitarium, pendulum, subglobosum vel globoso-trigonum, 11 cm longo, 13 cm diametro, numerosis phalangibus instructum. Phalanges late sensim cuneatae, usque ad basin angustam, longitudinaliter superficialiter canaliculatae. Carpella numerosa 8–16, multo profunde divisa, acuta, subflexuosa, duplicato-annulata, interibus majus et exterius minus. Stigmata reniformia vel U vel V formia. Sulcus longitudinalis ex stigmate basin versus brunneo-fasciatus.

Typus. JAPAN, Okinawa prefecture, Shimajiri-gun, Kitadaito village, Akaike, Kita-Daito Island, 25°56′N, 131°18′E, alt. 4 m, 17 Jan. 2008, *Ruliyana Susanti & Junko Miyamoto RSJM-01* (holo- KAG; iso- BO).

Trees to 4–5 m tall. Stems dichotomously branched, prickly, brown, greenish when young, 10–15 cm in diameter. Leaves spirally arranged, gradually tapering, 100–144 cm long, 5–5.5 cm wide in middle, 6–7 cm wide near sheath, apex attenuate, abaxially green and shining, adaxially rather dull, dry leaf coriaceus; longitudinal and transverse veins visible on both surfaces; apical-ventral pleat without prickles; marginal prickles pale brown with dark brown tips, antrorse, 1–2 mm long proximal to sheath to 2/3 length of leaf, 0.5–1 mm long in on remainder of leaf, 5–13 mm apart at base, 5–8 mm apart in middle, 2–3 mm apart near apex; midrib prickles brown, antrorse, 1–2 mm long from sheath to middle, 0.5–1 mm long near apex, 13–23 mm apart from base to middle, 2–3 mm apart near apex; leaf sheath not obvious, 6–7 cm long, 7–8 cm wide at base, 6 cm wide near sheath apex. Infructescence terminal, solitary, pendulous; syncarp 15–17 cm long, 11–13 cm in diameter, subglobose to rounded-trigonus, pedunculate; peduncle 12–24 cm long, trigonus, with 5–9 bracts per peduncle; bracts prickly on margin and midrib, leaf-like, more or less navicular, upper bracts gradually reduced; cephalium with 90–95 multicarpellate phalanges. Phalanges 45–55 mm long, 30–40 mm wide, 20–30 mm thick, rather trigonous to goblet shaped, cuneiform in proximal part, lower 1/2 connate into syncarp, green, becoming reddish orange or vermilion when mature; one phalange composed of (8–) 11 (–16) carpels arranged in two rows, inner rows arranged higher than outer row, thus phalange surface convex, (1/2–) 2/3 distal part free; apical sinus 25–30 mm deep; lateral sutures obvious; each carpel convex to acute, curved outward, terminating in a reniform, U- or V-shape stigma; stigma vertical rather than horizontal, 1–2 mm; longitudinal grooves from middle part of stigma to carpel base dark brown; mesocarp white membranaceous and brown fibrous; endocarp hard, osseous, tapering at both ends, 15–20 mm long in center, 4–5 mm wide, 10 mm away from the stigma. Staminate flowers unknown.

Japanese name. Hoso-mi-adan

Distribution and ecology. Interior of Kita-Daito Island near Akaike and near sugar cane plantations. *Pandanus daitoensis* grows in unplowed areas within populations of *P. odoratissimus* and (Fig. 1). Only four fruiting female individuals of *P. daitoensis* were observed. Sterile pistillate and staminate individuals are difficult to distinguish.

Etymology. The Japanese name of this spe-

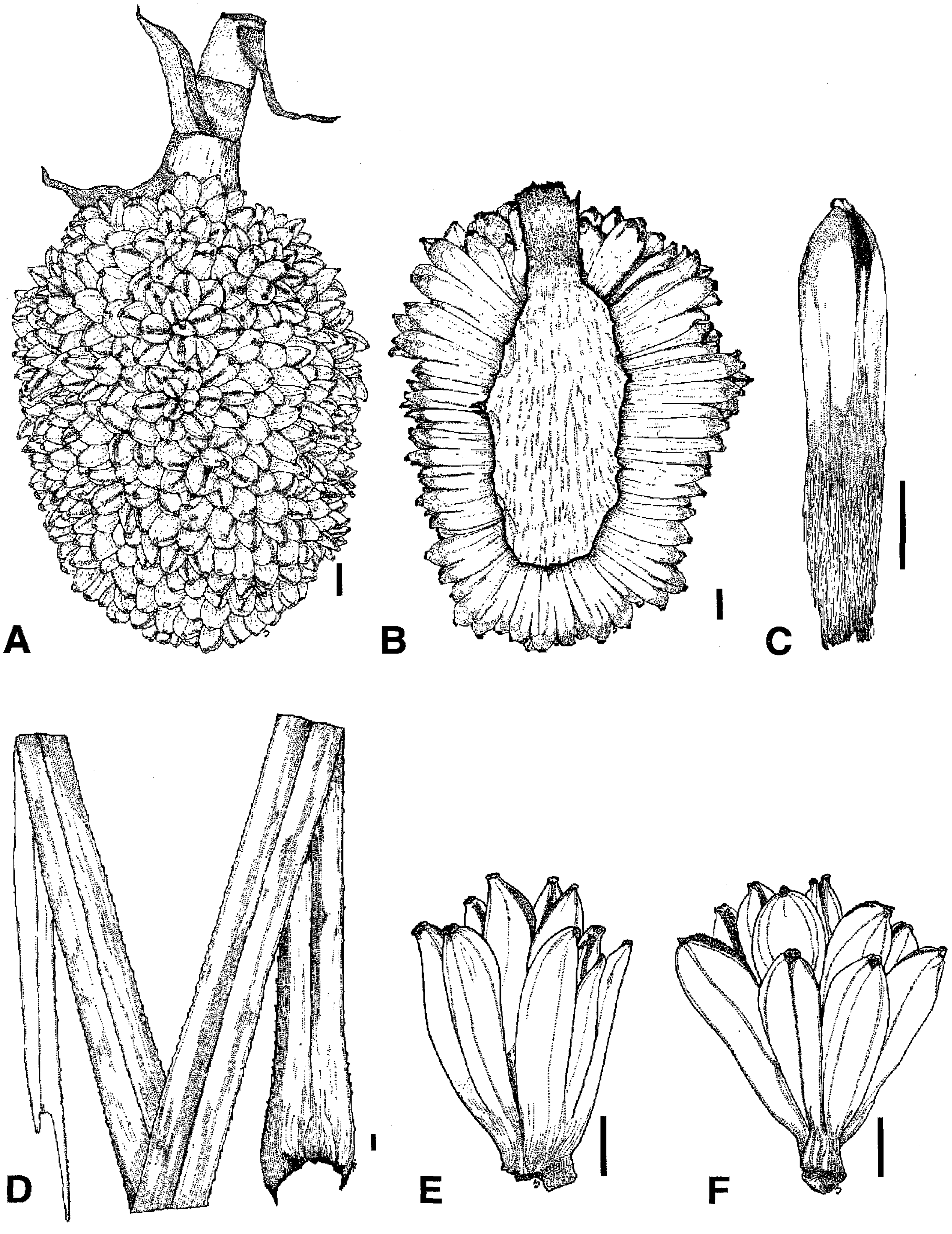

FIG. 2. *Pandanus daitoensis* Susanti & J. Miyam. A: cephalium. B: longitudinal section of cephalium. C: individual carpel. D: leaf. E: young phalange. F: mature phalange. Bar = 1 cm.

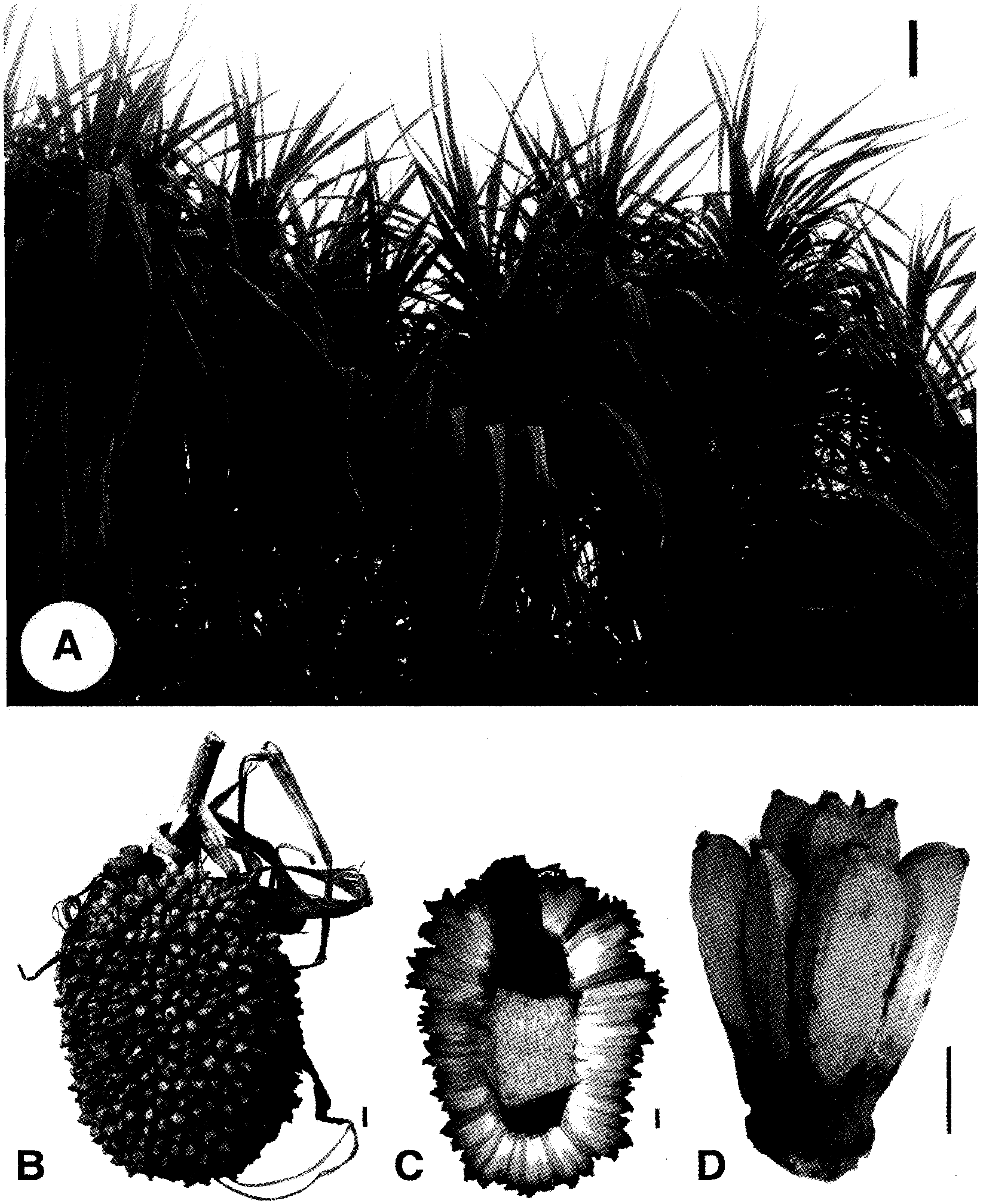

FIG. 3. Photographs of *P. daitoensis*. A: habitat. B: cephalium. C: cross section of cephalium. D: phalange. Bar = 10cm (A), 1 cm (B, C & D).

cies, "Hoso-mi-adan," given by the discoverers, means *Pandanus* with slender carpels.

Key to the species of *Pandanus* in Japan

1. Erect or more or less decumbent; leaf prickles more than 2 mm long; phalanges pentagonal to hexagonal, with flat surface composed of more than 5 carpels .... *P. odoratissimus* L.f.
1. Erect; leaf prickles less than 2 mm long; phalanges obovoid to fusiform or trigonous, with flat or curved surfaces composed of 3 to more than 8 carpels
    2. Phalanges obovoid to fusiform, with flat surface composed of 3 or 4 carpels .... *P. boninensis* Warb.
    2. Phalanges rather trigonous or goblet shaped, with curved surface composed of more than 8 carpels .... *P. daitoensis* Susanti & J. Miyam.

We are grateful to Ms. Rieko Oshiro and Mr. Morio Shiroma of Kitadaito Village for providing information on the new species and for their help in our field survey. We thank Mrs. Kazuaki Higashi and Kenyu Shinjo for their help in our field survey on Minami-Daito Island. Thanks are also due to Drs. Hidetoshi Nagamasu, Misako Mishima, Eko Baroto Waluyo and Yukino Ochiai for their help with our herbarium work, and Drs. Hiroshi Tobe, Tetsuo Ohi-Toma, Hidetoshi Kato, Mikiko Abe, Toshiki Uchiumi and Eizi Suzuki, and Ms. Keiko Mizunashi for their inspiring discussions and advice. A part of this research was supported by a grant from the Showa Seitoku Memorial Foundation.

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Received September 17, 2008; accepted May 10, 2009